PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Reeinforcing Means for use in Concrete Structures or the like

I, CARL ABRAHAM FORSSELL, a Swedish Subject, of Floragatan 12, Stockholm, Sweden, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to means for anchoring, within concrete or the like, reinforcing bars of wrought-iron which may have a section and surface of any known kind but without any subsequent special working of the surface thereof by cutting, filing or the like.

In previous constructions of reinforcing means for concrete structures, bonding stirrups have been formed by bending a metal rod or bar, of round, flat, or other section, into a loop round a reinforcing bar, and a wedge has been driven into the space between the loop and the bar to secure the stirrup transversely of the bar.

The present invention has for its object to provide an efficient fastening of an anchoring ring on a reinforcing bar to form a connection particularly resistant to tensile stresses acting longitudinally of the bar, and the invention is characterised by the fact that an anchoring ring of iron or other metal and the reinforcing bar are assembled so that the bar extends completely through the ring, the ring and the bar being secured to each other by one or more metallic wedges engaging a portion of the bar which has its original rolled surface unchanged, so as to form a connection resistant against tensile stresses, and in which said wedges are driven in longitudinally of the bar between the latter and seats formed as grooves in the inside of the ring, the surface of each seat having a shape as if it were generated by a straight line moving parallel with itself. Due to the particular seats for the wedges, a firm and reliable bond between the bar and the surrounding ring is obtained. The anchoring ring is adapted to bear against the concrete or the like in which the bar is to be anchored and embedded. The external outline of the anchoring ring may be of any suitable configuration, such as circular, oval or polygonal.

The construction above described provides an anchoring which may have a supporting surface of any selected size against the concrete about the reinforcing bar, and which may be arranged at the end of the bar or otherwise along the same at any suitable point. Two or more such anchoring rings may be arranged in a row behind one another if larger anchoring is desired at any portion of the bar than that which may be provided by a single anchoring only.

To increase the resistance to sliding between the reinforcing bar and the wedge, the surface of the latter bearing on the bar may be roughened in known manner or otherwise provided with irregularities of some kind or other, such as transverse channels. These irregularities on the surface of the wadge facing the bar may be adapted to irregularities of known type on the surface of the reinforcing bar, for instance to the irregularities of corrugated reinforcing bars. The surface between the wedge and the reinforcing bar may also be provided with a coating of some kind or other fit to form a bond between the surfaces so as to increase the resistance to movement between the wedge and the reinforcing bar, such coating being effected, for instance, by means of salt-water causing the parts to rust together. The surface between the wedge and the anchoring ring is smooth. It may be coated as stated above, so that the frictional resistance is increased on the wedge having been driven home; said surface may be coated with salt-water, for example. The resistance in the surface between the wedge and the reinforcing bar is preferably larger than in the surface between the wedge and the anchoring ring. If at any point the anchoring ring bears directly on the reinforcing bar, which is the case where only one wedge is being used, the above statements relative to the bearing of the wedge surface on the reinforcing bar hold true also with respect to the bearing surface between the anchoring ring and the reinforcing bar.

The inside of the anchoring ring is preferably adapted to the taper of the wedges. Here, a groove may preferably be provided in the inside of the ring to form a seat

[Price [redacted]]

for the wedge. The inclination of the bearing surface of this groove in contact with the wedge should agree with the taper of the wedge.

If the said groove is provided with angles or edges, the latter may cause concentrations of strains when the wedges are driven or pressed home and also when the wedge bond is subjected to a load. Hereby, the strength of the ring is reduced in a considerable degree. The same angles and edges in the wedge grooves cause difficulties in mass production if hammered or drop-forgings are made use of. To obviate these disadvantages, the surfaces of the wedge grooves and in the connections between them and the inside of the ring between the wedge grooves may be softly rounded, the same consisting preferably of segments of cylinder surfaces. These cylinder surfaces may be circular or oval, entirely or in part. Here, each wedge groove preferably constitutes a segment of a circular or oval surface. The inner surface of the ring between two wedge grooves is then preferably a plane surface, touching the two adjacent cylinder surfaces, which constitute the wedge grooves or seats. The latter is geometrically possible, inter alia where the cylindrical wedge seats are positioned radially with the same inclination in a circular ring. A wedge, which toward one side bears on such a wedge seat and toward the other side on a round bar, preferably has the section of a crescent, if desired with mutilated corners.

Where the direction of the forces in the reinforcing bar when in use is expected to be shifted or where it is desired to provide special protection against the results of an erroneously placed direction of the wedges, the wedges may be driven home from both sides between the anchoring ring and the reinforcing bar in the longitudinal direction of the latter. Here, some of the said wedge grooves, for instance half the number thereof, for the respective wedge inclinations on the inside of the anchoring ring may be made with an inclination in one direction, while the remainder is made with a wedge inclination in the opposite direction. In those parts of the reinforcing bar where the direction of the force may be expected to shift, it is possible, in place of providing wedges driven home from both sides in the same anchoring ring, as per above, to provide one or more anchoring rings mounted with their wedges turned all of them in one direction and one or more anchoring rings having all of their wedges turned in the opposite direction.

It is preferred to have the wedges arranged about the reinforcing bar on the lines of a regular polygon, so that the forces between the anchoring ring and the reinforcing bar may be equal as far as possible in the various wedges.

To facilitate a joint between the ends of two reinforcing bars, anchoring rings mounted on the two bar ends may be provided with screw threads on the outside thereof, so that the joint may be constituted by a pipe nut screwed in place. Here, two or more anchoring rings in a row may be fitted into the same pipe nut on each end of the bar, if a single anchoring ring would be found not to provide sufficient strength.

A joint between the ends of two drawn reinforcing bars may also be facilitated by providing the anchoring rings mounted on the respective bar ends with an end surface, which extends transversely of the bar and is plane, entirely or in part, on the side turned from the ends of the bars, and onto which surface it is intended to transfer the pressure from the ring to the surrounding concrete or brickwork. Cross-pieces of known type may bear on these two plain end surfaces, and these cross-pieces may, in turn, be kept together by means of bolts or straps.

In the mounting of the anchoring ring with its appertaining wedges on the round bar, it is preferred to proceed in such manner that the wedges when driven or pressed home between the bar and the ring are forced to maintain their position unmoved or nearly unmoved primarily relatively to each other, so that their movement relatively to the ring takes place simultaneously and by the same magnitude but, as a result of this, or by reason of some special arrangement, with an unmoved position also relatively to the bar. This does not exclude that the wedges may, to begin with, be brought into the desired position, by blows or a pressing effect, relatively to the ring and the bar. This having been done, the final pressing or beating operation is effected with the wedges and the bar in an unmoved position relatively to each other. The advantage of this method is that the surfaces between the bar and the wedge do not become planed off or polished by rubbing against each other during the driving or pressing operation, and that the friction or resistance from channels or other irregularities provided in this surface will not be reduced during the driving or pressing operation. In particular, this advantage holds true if the bearing surface of the wedge against the bar is channelled in a transverse direction. During the driving or pressing operation, the ring may be supported in known manner on an anvil, a sledge-hammer or some

other heavy and hard object. The beating or pressing is preferably effected simultaneously against the end of the bar and against the large ends of the wedges. In the beating, the end of the bar and the large ends of the wedges may instead be supported at the same time against an anvil, a sledge-hammer or some other heavy and hard object, while beating or pressing is effected against the opposite side of the ring. If the ring is to be wedged fast on the bar for a considerable distance inwardly from the end of the bar, one may proceed so that only the large ends of the wedges are supported on an anvil or some other heavy and hard object, while beating or pressing is effected against the opposite side of the ring. The wedges are thus driven into the ring, and the bar follows with the wedges.

When the bar and the wedges have been driven into the ring at the same time in the manner described above, without becoming displaced relatively to each other, a certain small permanent displacement will take place between the bar and the wedges when the wedge bond is for the first time subjected to load in the structure. This displacement is detrimental when the ring is intended to serve as an anchoring plate in the anchoring of the bar in concrete or the like. The displacement in question may be obviated or reduced by proceeding in such manner that the bar, after it has been pressed or beaten into the ring together with the wedges, and in unmoved position relatively to them, is then beaten or pressed relatively to the wedges. This beating or pressing relatively to the wedges may also take place, before the simultaneous beating or pressing both of the bar and the wedges is entirely terminated.

The simultaneous pressing of the bar and the wedges into the ring may be effected by the larger ends of the wedges being disposed on a level or nearly on a level with the end of the bar. It is then possible with the blow from an ordinary hammer or sledge to hit the ends of the bar and the wedges at the same time. If for some reason or other the ends of the wedges are not disposed on a level with the end of the bar, they may nevertheless be pressed or driven home at the same time by means of a tool, one side of which is adapted to bear on the ends of the wedges as well as on the end of the bar, while the other side thereof is adapted to be actuated by the bearing or pressing tool.

To facilitate beating or pressing of the bar relatively to the wedges, after the bar and the wedges, with their ends on the same level, have been beaten or pressed into the ring at the same same, an intermediate body may be inserted between the end of the bar and the beating or pressing tool, which intermediate body is only caused to bear on the end of the bar, but not on the ends of the wedges.

In connection with long reinforcing bars, the securing of the wedge bond between the bar and the ring is rendered convenient, if it is effected while the bar takes a horizontal position. In order then to obtain a bearing support for the ring in the beating against the bar and the wedges, the bar may be disposed in a horizontal notch in a lateral surface or an upper surface of an anvil, or in a similar notch in the surface of a sledge-hammer or some other heavy and hard object of known kind. The bar may be introduced into a notch, the free transverse dimension of which is slightly larger than that of the bar. The ring is caused to bear against a vertical surface of the anvil, and this surface affords the support required in the beating or pressing of the end of the bar and the wedges. In this arrangement, there may preferably be recessed, at the mouth of the notch and at the surface against which the ring is caused to bear, a groove of the width and depth required to prevent the points of the wedges from bearing on the anvil when they are driven into the ring. By providing various free widths for different notches in the anvil, the fitting of the bar into a notch of a suitable width is rendered possible. If a ring may be expected to become wedged fast for a distance inwardly on the bar, the beating may preferably be effected against the ring, while the large ends of the wedges are caused to bear against the vertical surface of the anvil. The portion of the bar projecting outside the large ends of the wedges may then be fitted into a horizontal notch in the anvil. Here, no groove should be recessed in the anvil at that mouth of the notch where the large ends of the wedges bear on the anvil, but the mouth of the notch should be adapted accurately to the bar. Then, if the number of the wedges is three at the most, the large ends of the wedges may be caused to bear directly on the surface of the anvil when the bar takes a suitable position. If the number of the wedges is larger and the wedges are uniformly spread about the bar, distributing intermediate insertions are preferably inserted over the notch in the anvil.

In securing the anchoring ring by pressing the same with its wedges onto the bar, it may be found suitable in certain cases to pull the bar in such direction that the wedges are then caused to be pressed into the ring. The ring then preferably bears

against a support on that side of the ring toward which the pulling effect is directed. In this securing of the anchoring ring, the magnitude of the pull is, as a rule, preferably equal to or larger than the maximum force which in the actual structure is intended to be transferred from the bar to the anchoring ring. The bond between the bar and the anchoring ring, when exposed to a force from the bar against the anchoring ring up to the force which has been used in the securing by a pulling effect, is practically rigid. At loading beyond this limit, perceptible movements between them will occur. Where a bar is anchored by means of two or more anchoring rings in a row behind one another, the change in length of the parts of the bar between the anchoring rings and the change in length of the concrete or the body of the wall surrounding the bar for the same distances will result in that the movement of the bar relatively to the concrete becomes smaller in connection with an anchoring ring which is placed nearer to the end of the anchored bar than in connection with an anchoring ring placed inwardly therefrom. The force which is transferred from the bar to the anchoring ring should, in spite of these dissimilarities in the movements, preferably be of the same magnitude in all of the anchoring rings mounted in a row behind each other. This may be obtained in that the force which has been used in securing the respective anchoring rings by a pulling effect is adapted in a suitable manner to be smaller in an anchoring ring, in connection with which the movement in the structure is greater between the bar and the concrete.

The invention is illustrated by way of example in the accompanying drawings.

Fig. 1 is a plan view of an anchoring ring according to the invention. Fig. 2 is a plan view of the same ring with the reinforcing bar thrust through the ring and with wedges beaten into position, and Fig. 3 shows a section on line A—B in Fig. 2. Fig. 4 is an end view and Fig. 5 a section on line C—D in Fig. 4 of a reinforcing means according to the invention. Fig. 6 shows the ring comprised in Figs. 4 and 5, after the remaining parts have been removed. Fig. 7 is an end view of one of the wedges, and Fig. 8 shows a section on line E—F in Fig. 7. Fig. 9 is an end view of the reinforcing bar, the anchoring ring and the wedges of a reinforcing means in accordance with a modification of the invention, and Figs. 10, 11, and 12 show sections on line G—H in Fig. 9 in various modifications of this reinforcing means. Fig. 13 is an end view of a reinforcing means according to the invention during a stage of the production thereof, and Figs. 14 and 15 are sections on line I—J in Fig. 13 in various modifications of this means. Fig. 16 is a detail section on a larger scale on line K—L in Fig. 15.

In Figs. 1—3, 1 designates the anchoring ring. 2 denotes grooves for wedges in one direction along the reinforcing bar, and 3 are grooves for wedges in the opposite direction. 4 designates the reinforcing bar. 5 are wedges with a taper in one direction, and 6 are wedges with a taper in the opposite direction. 7 denotes the contact surfaces between the reinforcing bar and the wedges, the surfaces of which latter should here be roughened, and 8 denotes the contact surfaces between the wedges and the anchoring ring, which surfaces should be smooth. 9 is the external surface of the anchoring ring, which may be threaded to afford joining with the ring in a similar reinforcing means with the aid of a pipe nut.

In Figs. 4—6, 10 designates a ring which here takes the form of an annular plate. 11 is the bar which is thrust through the ring, and which here takes the form of a round bar. 12 are the wedges between the ring and the bar. 13 are the surfaces on the inside of the ring, which surfaces form the wedge seats and which in the present case are of a circular-cylindrical configuration. 14 are the portions of the inside surface of the ring between the wedge seats, which portions are plane in the present case and form tangential planes to the circular-cylindrical surfaces 13. The chain-dotted lines 15 indicate the tangential lines between the plane surfaces 14 and the circular-cylindrical surfaces 13. 16 is a plane end surface of the anchoring ring, which surface is intended to bear on cross-pieces which extend transversely of the reinforcing bar and are used to join two such bars in known manner. The cross-pieces of one bar may be connected to that of the other by bolts or straps. In such a structure, the said cross-pieces transmit the pressure from the tensioned bar and from the anchoring ring to the concrete.

In Figs. 7 and 8 of the wedge, which is provided with mutilated edges, 17 designates the surface of the wedge adapted to bear on the ring and 18 denotes the surface thereof adapted to bear on the bar. The surface 18 of the wedge facing the bar may be channelled in known manner or otherwise prepared to increase the friction between the wedge and the bar.

In Figs. 9—10, 18 designates the anchoring ring for the reinforcing bar 19 and 20 are the wedges therebetween, said wedges having their large ends on a level

with the end of the bar 19. 21 is a portion of an anvil or sledge-hammer or some other hard and heavy object bearing on the anchoring ring, and 22 denotes a beating or pressing tool, such as an ordinary hammer or compressed air hammer bearing simultaneously on the ends of the bar 19 and of the wedges 20 on a level with each other.

In Fig. 11, the end of the reinforcing bar 23 is not on a level with the large ends of the wedges 20. 24 is a tool bearing at the same time on the reinforcing bar and the wedges, and 25 is a pressing or beating tool. 18, 20 and 21 are the same parts as indicated above in Figs. 9 and 10.

In Fig. 12, 18—21 are the same parts as in Figs. 9 and 10. 26 is an intermediate body resting on the end of the reinforcing bar 19, without touching the ends of the wedges 20. 27 is a beating or pressing tool, the forces from which are transferred to the bar 19 by the body 26.

In Figs. 13 and 14, 28 denotes the base for the anvil 29 having horizontal notches 30, 31 and 32 cut therein, said notches having rim portions 33, 34 and 35 recessed about the one mouth thereof in the vertical surface of the anvil. Disposed in the notch 31 is the reinforcing bar 36, with the anchoring ring 37 resting on that surface of the anvil where the rim portion 34 is recessed. The wedges 38 have their large ends on a level with the end of the bar 36. 39 is a pressing or beating tool.

In Figs. 15 and 16, 28, 29, 31 and 34 are the same parts as those illustrated in Figs. 14 and 15. 40 is a reinforcing bar with an anchoring ring 41 and three wedges 42 bearing with their large ends against the vertical surface of the anvil 29, which has no rim portion recessed about the bar, and one of which wedges is turned toward the bottom of the notch, all of the three wedges will be afforded ample bearing on the surface of the anvil 29, when the pressing or beating tool 43 actuates the side of the anchoring ring turned from the anvil.

The arrangement above described affords an anchorage for reinforcing bars of such nature that the bearing surface thereof against the concrete may be adapted in accordance with the nature of the concrete, which enables the dimension of the bar to be reduced according as a better quality of iron is brought into use. The anchoring is intended to be mounted by the iron workers so that the reinforcement will be entirely completed when the cement workers commence their work, It has been found by trials that annular plates, made as hammered forgings, and drop-forged wedges of the proportions indicated in Figs. 4—8 of the drawings afford sufficient strength to ensure that when the plates are used as bearing means the round bar is torn off, even when the latter has a strength of about 8.000 kilograms per square centimeter. No ruptures would then occur in the ring. No perceptible movement would take place between the round bar and wedges channelled on the inside thereof. The movement between the wedges and the ring would be slight. In unloading and loading up to loads lower than the maximum load previously used, no movement would take place between the bar and the ring. It has been confirmed by trials that by securing the bar in the wedge bond of the anchoring ring in the manner indicated above, prior to casting the bar into concrete, a practically rigid bond will be obtained between the bar and the anchoring ring, and that the total movement between the end of the bar and the concrete will then be of negligible magnitude (about 0.15 millimeters at round bar of 20 millimeters under a strain of 4.000 kilograms per square centimeter) if the bond has the proportions shown in Figs. 4—8.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. Reinforcing means for use in concrete structures or the like in which an anchoring ring of iron or other metal and a reinforcing bar are assembled so that the bar extends completely through the ring, the ring and the bar being secured to each other by one or more metallic wedges engaging a portion of the bar which has its original rolled surface unchanged, so as to form a connction resistant against tensile stresses, and in which said wedges are driven in longitudinally of the bar between the latter and seats formed as grooves in the inside of the ring, the surface of each seat having a shape as if it were generated by a straight line moving parallel with itself.

2. Reinforcing means as claimed in claim 1, wherein a plurality of anchoring rings are arranged on the bar in proximity to one another.

3. Reinforcing means as claimed in claim 1, wherein with the use of reinforcing bars of wrought iron having a corrugated surface produced by the initial rolling of the bar, the surface of the wedge or of the anchoring ring bearing on the reinforcing bar is provided with irregularities corresponding to the corrugations of the reinforcing bar.

4. Reinforcing means as claimed in claim 1, wherein the surface of the wedge

or of the reinforcing bar bearing on the anchoring ring is provided with a coating forming a bond between the surfaces and increasing the frictional resistance to movement between the wedge and the reinforcing bar.

5. Reinforcing means as claimed in claim 1, wherein the surface of the wedge facing the anchoring ring and the surface of the anchoring ring bearing on said first-mentioned surface are smooth.

6. Reinforcing means as claimed in claim 1, wherein a plurality of wedges in one and the same anchoring ring are arranged with their taper along the reinforcing bar in one direction, while the remaining wedges have their taper extending in the opposite direction.

7. Reinforcing means as claimed in claim 1, wherein the grooves for the wedges have the bearing surface thereof inclined corresponding to the inclination of the wedge.

8. Reinforcing means as claimed in claim 1, wherein the external surface of the anchoring ring is screw-threaded.

9. Reinforcing means as claimed in claim 1, wherein the end surface of the anchoring ring against which the pressure is intended to be transferred from the ring to the surrounding concrete is plane, entirely or in part.

10. Reinforcing means as claimed in claim 7, wherein the surfaces of the wedge groove are smoothly rounded both within the wedge grooves and in the junction to the adjacent surfaces of the inside of the ring.

11. Reinforcing means as claimed in claim 1, in which the wedge grooves are segments of cylidrical surfaces, the same being oval or circular, entirely or in part.

12. Reinforcing means as claimed in claim 9 or 10, wherein the internal surface of the ring between two adjacent wedge grooves is plane or nearly plane and touches the surfaces of both of the adjacent wedge grooves.

13. Reinforcing means as claimed in claim 1, wherein the cross section of the wedges is crescent-shaped, if desired with mutilated points.

14. Method of producing the reinforcing means claimed in any of the claims 1—12 by driving or pressing wedges in between an iron ring and a bar thrust therethrough, characterised in that the wedges remain stationary or nearly stationary in their position relatively to each other and relatively to the bar during the driving or pressing-in of the wedges

15. Method as claimed in claim 14 wherein the bar and wedges are driven oh pressed simultaneously into the ring and this ring is supported in known manner on an anvil, a sledge-hammer or some other heavy and hard object, characterised in that the driving or pressing operation is effected simultaneously against the ends of the bar and the wedges.

16. Method as claimed in claim 14 wherein the bar and the wedges are driven or pressed into the ring at the same time, characterised in that the bar and the large ends of the wedges are supported on an anvil, a sledge-hammer or other heavy object, while beating or pressing is effected on the opposite side of the ring.

17. Modification of the method claimed in claim 16 wherein only the large ends of the wedges are supported on an anvil or other heavy object, while beating or pressing is effected on the opposite side of the ring.

18. Modification of the method claimed in any of the claims 14—16, wherein the bar, on having been pressed or beaten into the ring together with the wedges, or before such pressing or beating operation is entirely terminated, is beaten or pressed relatively to the wedges.

19. Method as claimed in claim 14, wherein the pressing of the wedges in between the bar and the ring is effected by subjecting the bar to a pull, while the base surface of the ring bears on a support.

20. Method as claimed in claim 19, wherein the pull in the bar is equal to or greater than the pull which may occur in the bar when incorporated in the structure of which it is to form a part.

21. Method as claimed in any of claims 14, 15, 16 and 18, wherein the large ends of the wedges and the end of the bar are disposed in the same plane when being simultaneously subjected to blows of a sledge-hammer or some other heavy and hard object.

22. Method as claimed in any of claims 14, 15 and 16, wherein the bar is placed in a horizontal notch in the surface of an anvil or similar contrivance of known type, in a manner such that either the base of the ring or the large ends of the wedges are caused to bear against a vertical surface on the anvil and are afforded the support from this surface which is necessary when the beating or pressing into the ring is effected.

23. Reinforcing means for concrete structures or the like, substantially as hereinbefore described with reference to the accompanying drawings.

24. Method of producing reinforcing means for concrete structures or the like substantially as hereinbefore described.

Dated this 8th day of June, 1943.

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Chartered Patent Agents.

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Fig.1

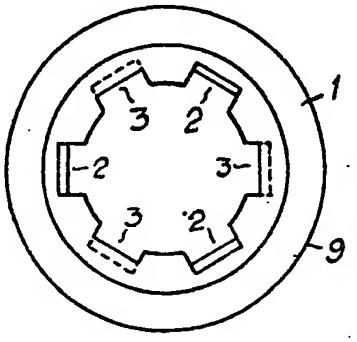


Fig.4

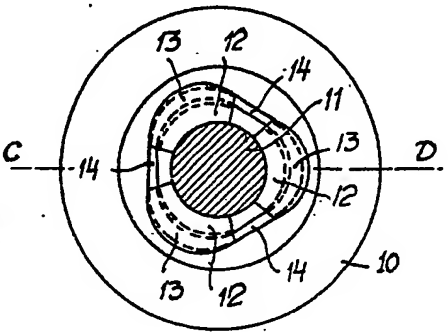


Fig.2

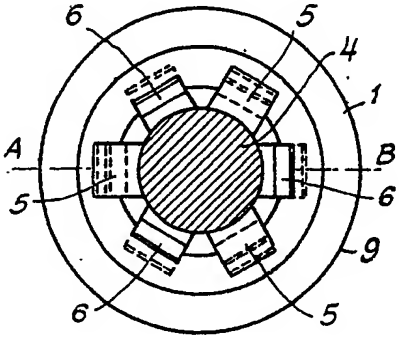


Fig.5

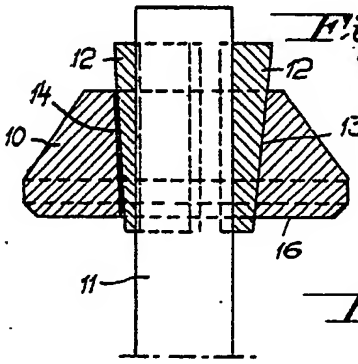


Fig.7

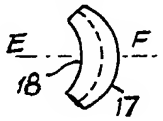


Fig.3

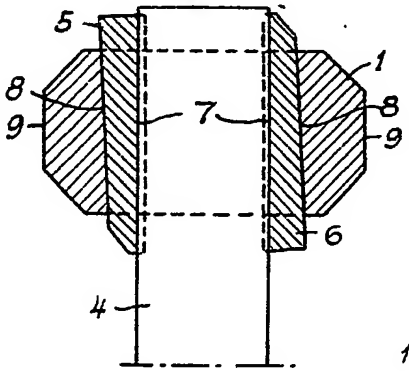


Fig.8

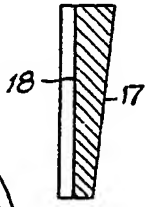


Fig.6

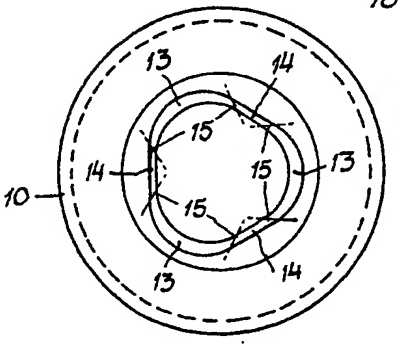


Fig. 9

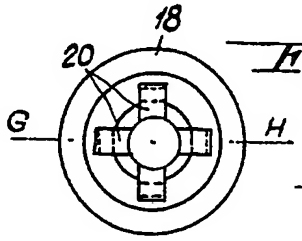


Fig. 11

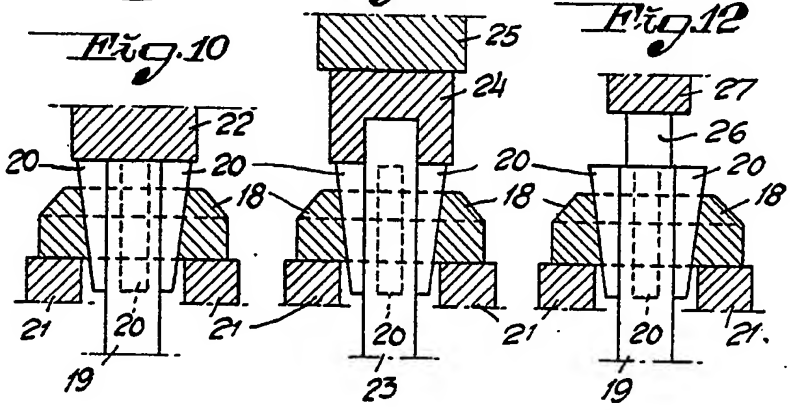


Fig. 10

Fig. 12

7

F

17

8

17

Fig. 14

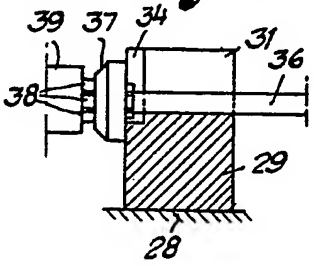


Fig. 13

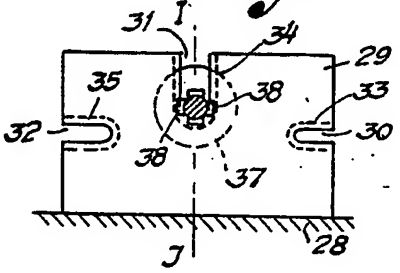


Fig. 16

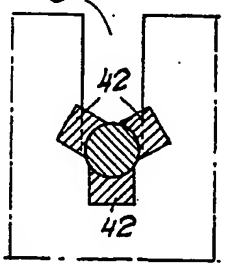
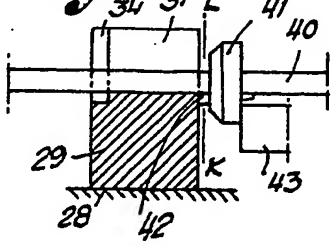


Fig. 15



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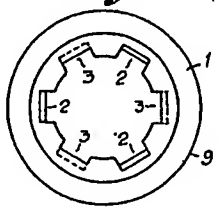
569,729 COMPLETE SPECIFICATION

SHEET 1

2 SHEETS
SHEET 2

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig.1



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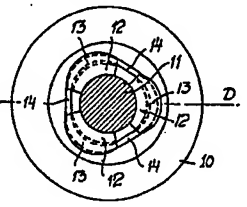
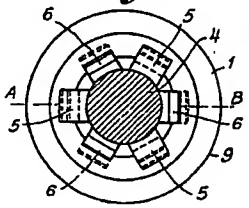


Fig.2



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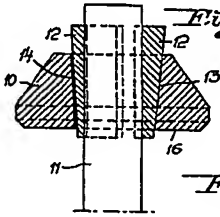


Fig.7

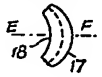


Fig.3

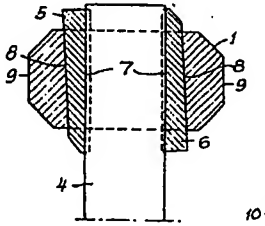
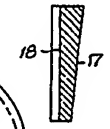


Fig.8



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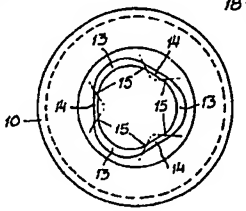


Fig.9

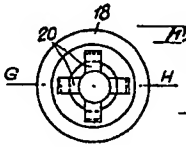


Fig.11

Fig.10

Fig.12

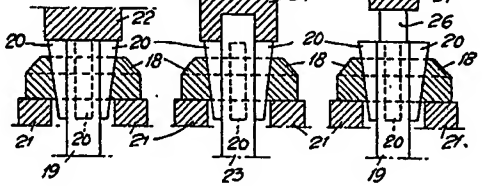


Fig.14

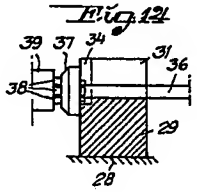


Fig.13

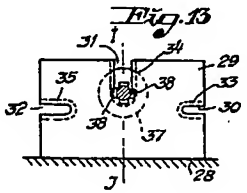


Fig.15

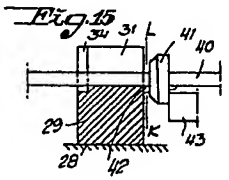
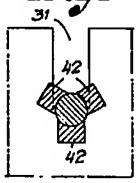


Fig.16



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